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User Manual:

iDrive for EnduraMAX Series Brushless DC Motors

(Document Part Number: 34-2002 R5)

This manual describes the installation and hardware operation of the EnduraMAX series BLDC motors with integrated drive manufactured by Allied Motion Technologies, Inc.

Every effort has been made to ensure the accuracy of the information in this manual. However, Allied Motion assumes no responsibility for any errors or omissions. The information contained in this document is subject to change without prior notice. We welcome your critical evaluation and suggestions for improvements to be made in future revisions.

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III. Inspection upon Receipt

All Allied Motion products are thoroughly inspected and tested before leaving the factory. Although our products are packaged with extreme care, it is important that the user complete a thorough inspection of the product upon arrival.

Examine the condition of the shipping container and materials. If damage is found, notify the commercial carrier involved. It is the user's responsibility to file any necessary damage claims with the carrier. Our products are shipped EXW (ex works), unless other arrangements have been made. Allied Motion is not responsible for carrier mishandling.

IV. Safety

	Read all provided documentation before assembly and commissioning. Failure, incorrect, or improper use of this equipment can cause death, personal injury, and consequential damage.
	Allied Motion disclaims any responsibility for such occurrence whereby unskilled and/or untrained personnel have incorrectly installed the equipment.
	Do not apply power to the motor without checking for proper wiring.

The final responsibility for the safe use of this motor is solely that of the user.

Allied Motion has used its best effort in the preparation of this manual. We reserve the right to make modifications, and alterations to improve the content and amend errors may be made to it without notice. Check the Revision History for a record of all published changes.

1.0 Drive Features

Certain models of the EnduraMAX brushless DC motor series include integrated drive electronics. Models with a speed-control-only drive (called sDrive models) are not addressed in this manual. Information for those drives may be found on the Allied Motion website. EnduraMAX models that include a bidirectional torque, velocity, and position control drive (called iDrive models) are addressed in this manual. EnduraMAX iDrive models are designed to operate from a DC voltage source. They are programmable and can control motor current/torque, velocity, or position. They obtain motor position information from an integrated magnetic encoder. See Table 1 for important iDrive specifications.

1.1 Motor Command Modes

The motor command modes supported by the drive are current mode, torque mode, velocity mode, and position mode.

1.2 Motor Command Sources

A motor command source can be derived from an analog input, programmable digital input, the IN Control user interface, or network communications (i.e. CANopen or Modbus RTU).

1.3 Communications

The drive has an RS-232 serial communication port for drive setup and control via the IN Control user interface. CANopen and Modbus RTU are available as communication bus options for control of the drive.

1.4 Motor Feedback

The motor is fitted with an integrated single-turn magnetic encoder with a resolution of 4096 counts per motor revolution.

1.5 Digital Inputs

The drive has six discrete inputs that can be programmed for different purposes (see Digital Inputs).

1.6 Digital Outputs

The drive has three discrete outputs that can be programmed for different purposes (see Digital Outputs).

1.7 Analog Inputs

The drive has one differential analog input which can be used for different purposes (see Analog Differential Input). Optionally, one single-ended input is available on pin 15 in place of the standard analog output (see Analog Single-Ended Input).

1.8 Analog Output

An analog output is available on pin 15 of the Drive Control connector (J2). The analog output can be programmed to output a 0 to 3.3 V signal that represents any of the drive variables described in the xiDrive Reference Manual (see section IN Control Software).

Table 1: EnduraMAX Integrated Drive Specifications

Amplifier Type	PWM (20 kHz), 4-quadrant control
Current Loop	DQ PI at 100 µs
Velocity Loop	PID/PDF at 200 µs
Position Loop	Proportional with feed-forward at 500 µs
Motor Feedback	Integral single-turn magnetic encoder (4096 counts/rev)
Input Voltage	Depends upon motor winding choice; Standard values include 12, 24, and 48 VDC
Drive Setup	RS-232 (460800 baud, 8 bit, no parity, 1 stop, no flow control) IN Control software interface
Network Communications	RS-485 / Modbus RTU (optional) - OR - CANopen (optional)
Digital I/O (programmable)	6 digital inputs 3 digital outputs, open-drain
Analog I/O	1 input, ±10 V, 12-bit resolution 1 analog output, 0 to 3.3 V, 12-bit resolution - OR - 2 inputs, ±10 V, 12-bit resolution (optional)
Brake Control	The optional integrated brake is software controlled by the drive
Operating Temperature	-40 to 85 °C
Storage Temperature	-65 to 125 °C
Protection Features	Over/under voltage Short-circuit protection Drive over-temperature I^2T current fold-back

2.0 Installation and Wiring

This section summarizes the recommended practices for installation of motor-drive equipment. These practices are based on and consistent with IEEE Standard 518-1982, "IEEE Guide for Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources", particularly Section 6, "Installation, Recommendations and Wiring Practices". This standard should be followed during assembly of our product to the driven equipment.

Normal operation and use of the motor is prohibited until the end-product complies with Directive 89/392/EEC (Machine Directive) and directive 89/336/EEC (EMC Directive). When required, the machine manufacturer must prove that the complete system conforms to all relevant European Directives. All equipment grounding should also be in conformance with applicable national and local electrical codes. Failure to follow recommended procedures might result in incorrect system operation and void the product warranty.

2.1 Grounding, Shielding and Cabling

Motion control systems contain circuitry that can be affected by electromagnetic interference (EMI). They also contain switching circuitry that can generate significant EMI at frequencies from 10 kHz to 300 MHz.

The potential exists for this switching noise to interfere with the correct operation of both the system and other electrical equipment in the vicinity. Immunity to and generation of EMI is greatly affected by installation techniques.

Proper grounding is necessary for the motor and drive to work properly in a system. There are several important system grounds that must be in place. This section describes wiring, grounding, and shielding techniques effective in designing and integrating a motor-drive system into your application.

2.1.1 Motor-Drive Grounding

The motor-drive is grounded through its front mounting plate. Ground is also available through the shell connections of the DC Power connector (J1). These grounds should be connected to earth ground in the user's system.

2.1.2 Control Signal Shielding

For higher EMI immunity and radiation, some applications may require that signals from the control source be wired to the drive in a shielded cable. This cable shield should be tied to the shielded housing of the Drive Control (J2) mating connector. It can also be beneficial for noise reduction to use twisted pairs for control signal wiring. Signals such as Analog Input 1+ and Analog Input 1- that are differential in nature may be wired in twisted pairs.

2.1.3 Techniques

Do not mix power and control signal wiring in the same conduit, duct, or wire tray without a minimum of one-inch (26 mm) separation.

Restrict all high voltage power wiring and power devices such as circuit breakers, contactors, fuses, etc., to an area separate from low-level control wiring.

No heat generating devices, such as transformers, inductors, braking resistors, etc., should be mounted near the motor.

The wiring must be properly strain relieved to ensure interconnects, wiring, and terminal connections do not become damaged.

2.2 DC Power Connector (J1)

The DC input power wiring is made to J1, the DC Power connector. Use care to ensure that the power connector is properly wired. J1 is a 2-pin high current male/female D-sub connector.

Note that currents of up to 40 A may be handled by J1. Care should be taken to use the proper wire size for the application current that is expected. At high currents, voltage drops due to wire resistance in power wiring can cause lower than expected drive voltages and hence lower than expected maximum motor speeds.

Table 2: DC Power Connector (J1)

Pin No.	Function	Description	Direction
A1	DC Input -	negative power connection (female pin)	Input
A2	DC Input +	positive power connection (male pin)	Input
Connector Shell	Protective Earth	main screening earth	Input

Table 3: DC Power Connector and Compatible Mates

Connector Type	Wire Gauge	Part No.	Manufacturer	Mating Connector Part No.
male/female high current DB-2	0.2 to 5.3 mm² 10 to 24 AWG	PR400N-2WK2MNB1-1107	Konmek	PS400N-2WK2FTB0
male/female high current DB-2 (optional sealed connector)	0.2 to 5.3 mm² 10 to 24 AWG	WPR400N-2WKMBZ1-1460	Konmek	PS400N-2WK2FTB0 / HW1-1

2.3 Drive Control Connector (J2)

The Drive Control connector is a 15-pin high density male D-sub connector.

2.3.1 Digital Inputs

There are six digital inputs available on pins 1 through 4, 6 and 7. The common for the inputs is pin 14. These inputs can be deactivated with voltages from 3 to 60 V with respect to COM (pin 14) or with the input left open. To activate the input the input voltage must be reduced to less than 1 V from COM. Note that these inputs are "active low" logic. They are inactive when left open and need to be driven low to be activated.

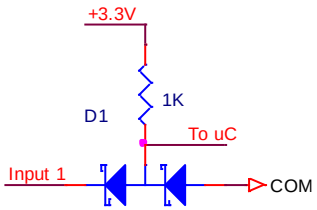

Figure 1: Schematic, Digital Inputs 1 Through 6

2.3.2 Digital Outputs

There are three digital outputs available on pins 9, 11, and 12. The common for the outputs is pin 14. These are open collector outputs and can drive loads with voltages up to 60 V. Load current is limited to 100 mA. The outputs are current sinking only. The outputs can be described as active low outputs, as when software activates an output the transistor will turn on and the output will be low. When the output is deactivated, the output will be high (as long as the user pulls the output up to a rail voltage with an appropriate load resistor).

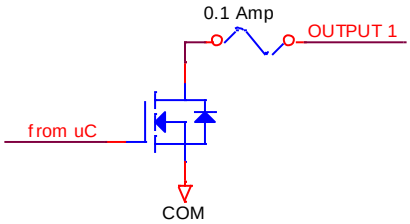

Figure 2: Schematic, Digital Outputs 1 Through 3

2.3.3 Analog Differential Input

There is one differential analog input available on pins 5 and 10. Referred to as Analog Input 1, this differential input is scaled to receive analog signals of ± 10 V. Analog Input 1 is configured as shown below. The analog input variable ADC1 represents the A/D conversion of the analog input. The A/D conversion accuracy is 12 bits.

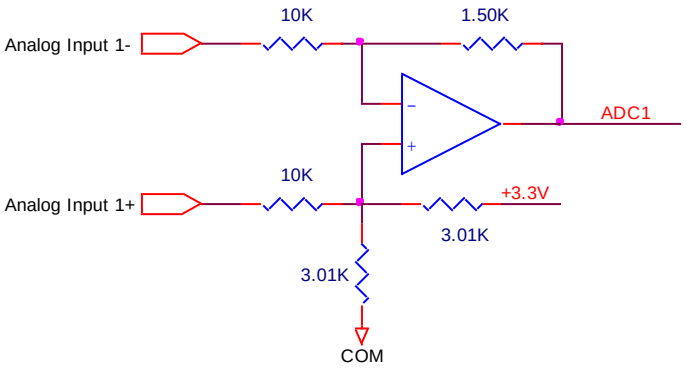

Figure 3: Schematic, Analog Differential Input (Analog Input 1)

2.3.4 Analog Single-Ended Input

There is one singled-ended analog input available on pin 15 that is measured with respect to COM (pin 14). Referred to as Analog Input 2, this single-ended input is scaled to receive analog signals of ± 10 V with respect to COM (pin 14). Analog Input 2 is configured as shown below. It is also capable of being used as a 4 to 20 mA analog input as there is a 499 Ω resistor which can turn the 4 to 20 mA current into voltage for the drive to read. The input variable ADC2 represents the A/D conversion of the analog input voltage. The input variable A420 represents the A/D conversion of the 4 to 20 mA current. The A/D conversion accuracy is 12 bits.

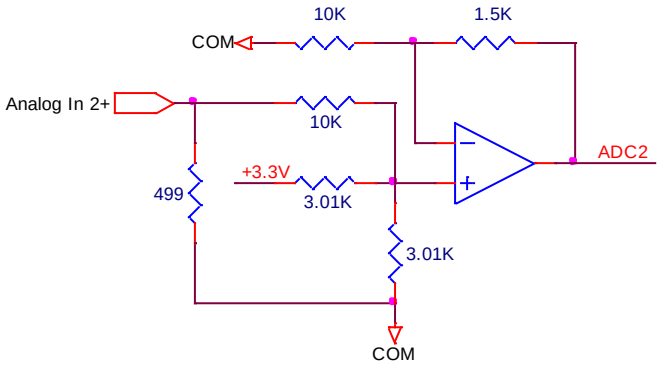

Figure 4: Schematic, Analog Single-Ended Input (Analog Input 2)

Table 4: Drive Control Connector (J2)

Pin No.	Function	Description	Direction
1	Digital Input 1	Input: 3 to 60 V 1 kΩ pull-up to +3.3 V internal supply, diode isolated	Input
2	Digital Input 2	Input: 3 to 60 V 1 kΩ pull-up to +3.3 V internal supply, diode isolated	Input
3	Digital Input 3	Input: 3 to 60 V 1 kΩ pull-up to +3.3 V internal supply, diode isolated	Input
4	Digital Input 4	Input: 3 to 60 V 1 kΩ pull-up to +3.3 V internal supply, diode isolated	Input
5	Analog Input 1 +	±10 V analog input 1 positive differential input	Input
6	Digital Input 5	Input: 3 to 60 V 1 kΩ pull-up to +3.3 V internal supply, diode isolated	Input
7	Digital Input 6	Input: 3 to 60 V 1 kΩ pull-up to +3.3 V internal supply, diode isolated	Input
8	RS-232 receive	RS-232 drive receive input	Input
9	Digital Output 1	Output: open collector 1 kΩ source resistor, 60 V, 10 mA (max)	Output
10	Analog Input 1 -	±10 V analog input 1 negative differential input	Input
11	Digital Output 2	Output: open collector 1 kΩ source resistor, 60 V, 10 mA (max)	Output
12	Digital Output 3	Output: open collector 1 kΩ source resistor, 60 V, 10 mA (max)	Output
13	RS-232 transmit	RS-232 drive transmit output	Output
14	COM	Common (for analog and digital inputs/outputs)	I/O
15	Analog Output -OR- Analog Input 2 +	0 to 3.3 V, 12-bit resolution -OR- ±10 V analog input 2 (single-ended, read with respect to Common) 500 Ω resistance to Common (4 to 20 mA compatible)	Output -OR- Input
Connector Shell	Screen	Main screening earth	I/O

Table 5: Drive Control Connector and Compatible Mates

Type	Wire Gauge	Part No.	Manufacturer	Mating Connector Part No.
male high density DB-15	0.08 to 0.32 mm² 22 to 28 AWG	HT0-15MBS6-1085	Konmek	HS0-15FTBO
male high density DB-15 (optional sealed connector)	0.08 to 0.32 mm² 22 to 28 AWG	WHT0-15MZBS6	Konmek	HS0-15FTBO with HW1-1 shroud

2.4 CANopen Connector (J3)

CANopen is an available option for the EnduraMAX iDrive Series. CANopen is a standard serial communication interface. If the CANopen option is incorporated into the drive, it is available at the 9-pin male D-sub connector. This connector conforms to the CANopen specification.

2.4.1 CANopen Isolation and Power

The CANopen port is optically isolated from the drive. As such it requires that the CAN transceiver and isolation circuitry be powered from the J3 connector. CAN power requirements are that power is to be supplied from CANV+ to CCOM. The allowed voltage range is from 8 V to 28 V at up to 100 mA of current draw.

2.4.2 Drive Power Control

The drive will shut down and draw less than 100 µA of current from the power inputs when the voltage from CANV+ to CCOM is less than 2 V. This feature allows the drive to be connected to a battery and be powered up and down with the CANV+ power input.

Table 6: CANopen Connector (J3)

Pin No.	Function	Description	Direction
1	N/C	No connection	N/C
2	CANL	CAN negative communication line	I/O
3	CCOM	CAN Common	Input
4	N/C	No connection	N/C
5	N/C	No connection	N/C
6	N/C	No connection	N/C
7	CANH	CAN positive communication line	I/O
8	N/C	No connection	N/C
9	CANV+	CAN Power (necessary as the CAN interface is isolated from drive control power)	Input
Connector Shell	Screen	Main screening earth	Input

Table 7: CANopen Connector and Compatible Mates

Connector Type	Wire Gauge	Part No.	Manufacturer	Mating Connector Part No.
male DB-9	0.08 to 0.32 mm² 22 to 28 AWG	DT0-09MBS6-1085	Konmek	DS0-09FTBO
male DB-9 (optional sealed connector)	0.08 to 0.32 mm² 22 to 28 AWG	WDT0-09MZBS6	Konmek	HS0-15FTBO with HW1-1 shroud

2.5 Modbus RTU Connector (J3)

Modbus RTU is an available option for the EnduraMAX iDrive Series. Modbus RTU is a standard serial communication interface. If the Modbus RTU option is incorporated into the drive, it is available at the 9-pin male D-sub connector.

Table 8: Modbus RTU Connector (J3)

Pin No.	Function	Description	Direction
1	COM	RS-485 common	Input
2	N/C	No connection	N/C
3	N/C	No connection	N/C
4	Tx/Rx-	RS-485 2 wire negative	I/O
5	N/C	No connection	N/C
6	N/C	No connection	N/C
7	N/C	No connection	N/C
8	Tx/Rx+	RS-485 2 wire positive	I/O
9	N/C	No connection	N/C
Connector Shell	Screen	Main screening earth	Input

Table 9: Modbus RTU Connector and Compatible Mates

Connector Type	Wire Gauge	Part No.	Manufacturer	Mating Connector Part No.
male DB-9	0.08 to 0.32 mm² 22 to 28 AWG	DT0-09MBS6-1085	Konmek	DS0-09FTBO
male DB-9 (optional sealed connector)	0.08 to 0.32 mm² 22 to 28 AWG	WDT0-09MZBS6	Konmek	HS0-15FTBO with HW1-1 shroud

2.6 Brake

A holding brake is an option with the EnduraMAX iDrive Series. Brake control is described in the xiDrive Reference Manual (see section IN Control Software).

2.7 Fan

Some models in the EnduraMAX iDrive Series are equipped with an external fan on the drive electronics. This fan is activated only when the drive heat sink temperature exceeds 60 °C.

3.0 Motor Temperature Ratings

The EnduraMAX motors have been evaluated for thermal performance. Data regarding this testing is available in respective datasheets. Each motor has been rated for its maximum performance (i.e. torque and speed available) under the following conditions:

Mounted to a 200 × 200 × 10 mm aluminum plate

Ambient temperature is 23 °C

Still air

The drive electronics have thermal sensing and are protected from thermal damage. However, motor winding temperature is not sensed. If the motor is to be operated in conditions more severe than those described above, derating of motor performance may be required. Contact Allied Motion applications engineering for assistance in determining appropriate derating factors for operation in harsh environments.

4.0 Faults and Troubleshooting

4.1 Fault Detection

The following faults are detected and acted upon in the drive:

4.1.1 Input Voltage Reverse Polarity Protection

The motor-drive is protected against reverse input voltages of up to 100 V.

4.1.2 Over-Voltage Detection

The motor-drive is protected against input over-voltages of up to 100 V. If a DC bus voltage greater than 60 V is detected, the drive is disabled and a Bus Over-voltage fault is set.

4.1.3 Under-Voltage Detection

If a DC bus voltage less than 8 V is detected when the drive is enabled, the drive is disabled and a Bus Under-voltage fault is set.

4.1.4 I^2T Protection

Continuous output currents are limited to the motor continuous rated current (parameter IMAX of the drive's Motor Parameters). Continuous current limiting is accomplished with an I^2T current limiting scheme.

4.1.5 Short Circuit Protection

The drive is fully protected from phase-to-phase and phase-to-ground short circuits in the motor.

4.1.6 Drive Over-Temperature

The drive's power components are monitored for excessive temperature. When the temperature limit is reached, the drive is disabled and a Drive Over-Temperature fault flag is set. The drive temperature can be monitored in the IN Control user interface by displaying the variable TPWR. The drive will flag an Over-Temperature fault and be disabled if the drive temperature reaches 100 °C.

4.1.7 Fault Monitoring and Resetting

Faults can be reset through the IN Control user interface, by assigning a digital input as a fault reset input, or by power cycling the drive.

4.2 Troubleshooting

4.2.1 Motor Does Not Move

Insure that the drive is powered. This can be verified by communicating with the drive using IN Control. The drive status is available in IN Control at the bottom of the program screen. IN Control will display either DIS (drive disabled), ENA (drive enabled), or FLT (drive faulted).

In the event of a fault consult the Diagnose screen in IN Control. This screen will display drive fault information and allow the fault to be reset when problem is resolved.

Verify that you are supplying the correct DC voltage to the drive. Check parameter VDC in the monitor window.

Verify that all the input and outputs are correctly wired.

Verify that a disabling input is not active.

Verify that the motor output is not blocked and that the brake, if present, is released.

If the motor does not move when in current mode, verify that the maximum motor current IMAX is set to a sufficiently high value.

If the motor does not move when in velocity or position mode, verify that the velocity loop parameters are set properly and that the torque limit TLIM is set to a sufficiently high value.

4.2.2 Communication Errors

Check the communication cable for proper wiring and loose connections.

Verify that the correct COM port is selected in the “Connect” drop-down of IN Control.

4.2.3 Erratic Motor Behavior

Erratic motor behavior can be the result of improper motor and cable grounding. See Grounding, Shielding and Cabling for details.

Erratic motor behavior may also be the result of poor velocity or position loop tuning if the motor is being used in either of these modes.

5.0 System Accessories

5.1 Mating Connectors and Cables

Standard iDrive accessories, including mating connector kits, assembled cables, and cable kits as described below may be purchased from Allied Motion. Contact Allied Motion application engineering to request further customization, such as additional cable lengths, and IP67 rated sealed connectors.

Table 10: Mating Connector Kit

Part No.	Description	Connectors Included
AC-CNK0001	Non-sealed mating connectors	J1 mating connector, male/female high current DB-2 (w/solder terminals) J2 mating connector, female high density DB-15 (w/solder terminals) J3 mating connector, female DB-9 (w/solder terminals)

Table 11: Assembled Cables

Part No.	Description	Function
AC-CBL0001	RS-232 Programming Cable, 1 m length	J2 mating connector to female DB-9, suitable for connecting the motor drive to an RS-232 port, enabling serial communication with the drive
AC-CBL0002	Interface Cable, 1 m length	J2 mating connector to flying leads.
AC-CBL0003	Interface Cable, 3 m length	
AC-CBL0004	CANopen / Modbus Cable, 1 m length	J3 mating connector to flying leads
AC-CBL0005	CANopen / Modbus Cable, 3 m length	
AC-CBL0006	Power Cable, 10 AWG, 1 m length	J1 mating connector to flying leads, suitable for currents up to 30 A
AC-CBL0007	Power Cable, 10 AWG, 3 m length	
AC-CBL0008	Power Cable, 14 AWG, 1 m length	J1 mating connector to flying leads, suitable for currents up to 15 A
AC-CBL0009	Power Cable, 14 AWG, 3 m length	
AC-CBL0010	USB to RS-232 Converter	Provides necessary conversion between RS-232 Programming Cable and USB port, enabling communication with the motor drive from a PC, using the IN Control software

Table 12: Cable Kits

Part No.	Description	Assembled Cables Included
AC-CBS0001	1 m length, 10 AWG cable kit	AC-CBL0002 AC-CBL0004 AC-CBL0006
AC-CBS0002	3 m length, 10 AWG cable kit	AC-CBL0003 AC-CBL0005 AC-CBL0007
AC-CBS0003	1 m length, 14 AWG cable kit	AC-CBL0002 AC-CBL0004 AC-CBL0008
AC-CBS0004	3 m length, 14 AWG cable kit	AC-CBL0003 AC-CBL0005 AC-CBL0009

5.2 IN Control Software

IN Control is a Windows®-based software application which enables the user to configure and control from a PC the iDrive for the EnduraMAX Series BLDC motors. The software and reference manual for IN Control are available for download at:

http://controls.alliedmotion.com/Home.aspx

6.0 Revision History

Revision	Description of Change	Date
R1	Initial release.	October 2011
R2	Corrected pin numbering error in Table 2.	January 2012
R3	Adjusted table leading and font. Placed captions below figures to adhere to writing standards. Reorganized content. Corrected part numbering errors.	February 2012
R4	Edited Table 1 to clarify available options and corrected upper storage temperature range. Eliminated unimplemented secondary encoder input from available options. Corrected J1 mating connector part number. Revised troubleshooting procedure.	November 2013
R5	Identified Analog Output as standard feature.	November 2013